

A music recommendation system based on music data grouping and user interests

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ABSTRACT

With the growth of the World Wide Web, a large amount of music data is available on the Internet. In addition to searching expected music objects for users, it becomes necessary to develop a recommendation service. In this paper, we design the Music Recommendation System (MRS) to provide a personalized service of music recommendation. The music objects of MIDI format are first analyzed. For each polyphonic music object, the representative track is first determined, and then six features are extracted from this track. According to the features, the music objects are properly grouped. For users, the access histories are analyzed to derive user interests. The content-based, collaborative and statistics-based recommendation methods are proposed, which are based on the favorite degrees of the users to the music groups. A series of experiments are carried out to show that our approach is feasible.

Keywords

music recommendation, perceptual properties, access histories, recommendation methods, user profiles

1. Introduction

Concerning a large amount of various data available on the Internet, there exist **websites** which provide services for users to look for **useful** data. For text data in webpages, the **websites** providing keyword-based searching or recommendation are developed, such as the search engine of Yahoo! [Yaho] and the book recommendations of Amazon [Amaz]. For multimedia data, however, the **websites** providing such kinds of services are still limited.

Regarding the music recommendation, a preliminary recommendation can be accomplished by notifying users when new music objects arrive. The mechanism for the notification service is described as follows. For an incoming music object, the

corresponding description is manually attached to the music object, such as the music genre, title, and composer. The users are required to specify their preferences in music. The users' preferences will be compared with the descriptions of the music objects. If matched, the system will send a notification of the matched music objects to those interested users.

In this paper, we propose an alternative way of music recommendation. Instead of textual descriptions, we consider the perceptual properties of music objects, such as pitch, duration, and loudness, which can be directly extracted from the music objects. For users, the preferences are derived from the access histories and recorded in profiles. Three recommendation methods are proposed to approach the corresponding goals. Based on the perceptual properties of the music objects and the elaborated profiles, better recommendation can be obtained by applying our methods.

The rest of this paper is organized as follows. In Section 2, we introduce the music recommendation system in which the modules of track selector, feature extractor and classifier are detailed. In Section 3, we present the three recommendation methods which have been implemented in our system. In Section 4, we perform a series of experiments and illustrate the experiment results to show that our approach is feasible. Finally, in Section 5, we conclude this paper.

1.1 Related work

Two approaches for a recommendation system have been discussed in the literature, *i.e.*, the content-based filtering approach and the collaborative filtering approach.

In the content-based filtering approach, the representations of the data items which have been accessed in the past are used as the user profiles. Based on the user profiles, the system recommends only the data items that are highly relevant to the user profiles by computing the similarities between the data items and the user profiles. Examples of such systems are **NewsWeeder** [Lang95], **Infofinder** [Krul96], and **News Dude** [Bill99]. In this approach, the representation of data items and the description of user preferences in profiles are key issues which dominate the effectiveness of recommendation.

Instead of computing the similarities between the data items and the user profiles, the collaborative approach computes the similarities between the user profiles. Users of similar profiles will be grouped together to share the information in their profiles. The main goal of the collaborative approach is to make

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recommendation among the users in the same group. Examples of such systems are Ringo [Shar95] and Sitemeer [Ruck97]. In the collaborative filtering approach, the system may have a high possibility to recommend unexpected data items by the nature of information sharing.

Some systems use both content-based and collaborative filtering approaches. For example, Tapestry [Gold92] and GroupLens [Kons97] allow users to comment on Netnews and group users by computing the similarities of their ratings of newsgroups. In addition, for the process of recommendation, users have to specify their profiles and describe the features of data items which they are interested in. For the video data, the recommendation system is developed in [Basu98]. The user interests are derived from the types, the actors, and the scenarios of videos that the user accessed in the past. The users are also required to specify the satisfactory degrees of the accessed videos. With respect to videos, users who specify similar satisfactory degrees will be grouped together for collaborative recommendation. Similarly, the Personalized Television system [Smit00] provides a personalized list of recommended programs. The FAB system [Bala97] analyzes the accessed webpages to derive the user profiles and compares the user profiles to group users for collaborative recommendation. The OTS [Wu01] employs the techniques of association rule mining to derive user interests and behaviors to be used as the user profiles. After classifying the user profiles into clusters, three kinds of recommendation methods are then provided using these clusters.

2. Music Recommendation System

The Music Recommendation System (MRS) is a website which provides the service of music recommendation based on music data grouping and user interests. The music objects in the database of MRS, as well as the incoming music objects, are candidates for music recommendation. As shown in Figure 1, the system consists of seven function blocks, namely, the track selector, the feature extractor, the classifier, the profile manager, the recommendation module, the interface, and the database. When a new music object is inserted in the database of the MRS, it goes through two function blocks, i.e., track selector and feature extractor. According to the extracted features, the incoming music object is properly assigned to certain music group by the classifier function block. These three function blocks will be described in the following subsections. The profile manager and recommendation methods will be presented in Section 3. In addition, the interface will be shown in Section 4.

2.1 Track Selector

In the MRS, the music objects are of MIDI format. There are two kinds of music objects, i.e., monophonic music objects and polyphonic music objects. Usually, a polyphonic music object consists of several tracks, one for melody and the others for accompaniment. We observe that the track for melody contains much more distinct notes with different pitches than the tracks for accompaniment. In [Uitd98], the method used to extract a melody from a MIDI file is developed, which considers all tracks and chooses the notes with the highest pitch for the melody. This method may result in an extracted melody containing the notes which belong to the tracks of accompaniment.

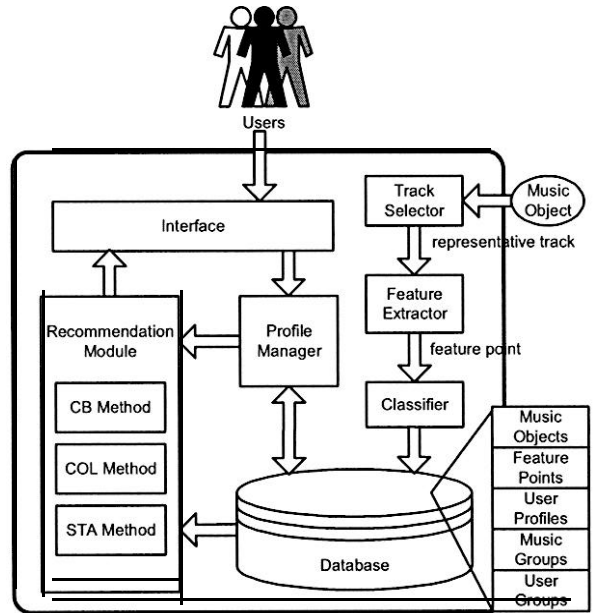


Figure 1. The system architecture of the MRS.

Different from the method used in [Uitd98], we use a measure of *pitch density* to select a *representative track*. The pitch density of a track is defined as follows:

$$\text{pitch density} = \frac{NP}{AP} \quad (1)$$

where NP is the number of distinct pitches in the track

AP is the number of all distinct pitches in MIDI standard, i.e., 128.

The track with the highest density is selected as the representative track of a polyphonic music object.

2.2 Feature Extractor

The purpose of the feature extractor is to extract features from the perceptual properties of the representative track. The six features are described as follows:

- **Mean (MP) and standard deviation (SP) of the pitch values**
From the representative track, we compute the mean and standard deviation of the pitches.

1 Pitch density (PD)

The definition of pitch density has been given in equation (1).

1 Pitch entropy (PE)

The *pitch entropy* PE, derived from [Sayo00], is defined as follows:

$$PE = -\sum_{j=1}^{NP} P_j \log P_j \quad (2)$$

where P_j is defined as follows:

$$P_j = \frac{N_j}{T} \quad (3)$$

